APPENDIX TO RADON AND RADON-DAUGHTER CONCENTRATIONS IN AIR IN THE VICINITY OF THE ANACONDA URANIUM MILL

by

**Michael H. Momeni, J. B. Lindstrom,
C. E. Dungey, and Walter E. Kisielleski**

HUMAN-EXPOSURE PATHWAYS FROM URANIUM-MINING AND -MILLING FACILITIES

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Table A1. Stratigraphic Description and Water-Bearing Characteristics^a

Age	Unit	Thickness (ft)	Lithologic Characteristics	Water-Bearing Characteristics
Quaternary	Recent alluvium	0- 50	Valley-fill deposits of unconsolidated silt, clay, sand, and gravel.	Alluvium and basalt form a single, important aquifer. Basal alluvium most productive portion. Water quality usually good.
	Basalt	0- 200	Dense to vesicular basalt, extruded as lava flows of varying thickness and extent.	
	Older alluvium	0- 100	Valley-fill deposits of sand, gravel, silt, and clay.	
Quaternary (?) and Tertiary	Basaltic rocks	-	Basaltic cinder cones, plugs, and dikes.	Unknown.
Tertiary	Extrusive rocks	0- 300	Basalt, rhyolite, and tuff breccia.	Yields water to springs at base of basalt at favorable locations.
Cretaceous	Mesaverde Group, undivided	1000-1500	Silty shale and thin- to thick-bedded fine-grained sandstone, with some local coal beds.	Not utilized in mine or mill vicinity.
	Mancos Shale	700- 800	Platy, calcareous marine shale, with some thick-bedded sandstones in lower part.	Ires Hermanos sandstone member yields small amounts of fair-quality water in mine vicinity.
	Dakota Sandstone	50- 100	Massive, medium- to coarse-grained sandstone, locally with interbedded siltstone.	Not utilized for water supply in mine or mill area.
Jurassic	Morrison Formation	300- 500	Brushy Basin (upper) member consists of mudstone and arkosic sandstone, contains Jackpile sandstone at top of unit. Waste-water Canyon member, sandstone and mudstone. Recapture Creek (lower) member, alternating sandstone and siltstone or mudstone.	Brushy Basin and Westwater Canyon members yield small quantities of fair- to poor-quality water. Recapture Creek member not known to yield groundwater.
	San Rafael Group, undivided	450- 700	Fine- to medium-grained, in part silty sandstone, siltstone, and claystone, with some limestone in lower part, and massive cross-bedded sandstone in basal part.	Bluff sandstone formation is utilized for stock watering in Jackpile mine area. Yields small quantities of poor-quality water.
Triassic	Wingate Sandstone	60- 100	Massive, cross-bedded sandstone.	Not utilized in mine or mill areas.
	Chinle Formation	1400-1600	Siltstone and mudstone, with interbedded silty sandstone and some conglomeratic sandstone. Some thin limestones in the upper part, a thick sandstone unit near the middle, considerable sandstone in the lower part.	Utilized for domestic-stock watering and occasionally irrigation supply. Water quality fair to poor.
Permian	San Andres Limestone	80- 150	Thick-bedded to massive limestone, sandy limestone, and limy sandstone. The limestone strata are cavernous in many localities.	San Andres and Glorieta formations constitute a single aquifer. Most highly developed aquifer in Bluewater area. Water quality good near outcrop; deteriorates with distance from outcrop.
	Glorieta Sandstone	125- 300	Thick-bedded to massive, well-sorted medium-grained sandstone. Some interbedded siltstone in basal part.	
	Yeso Formation	350- 500	Upper part fine-grained silty sandstone and mudstone with some layers of evaporites and limestone. Lower part fine-grained sandstone.	Yields to several wells on flank of Zuni uplift. Except in outcrop areas, water is of poor quality.
	Abo Formation	500- 800	Arkosic sandstone and siltstone, with numerous layers of conglomerate in lower part.	Not utilized in area. Contains water of poor quality and is deeply buried.
Pennsylvanian (?)		0- 480	Arkose and conglomerate, and a few thin arkosic-limestone lenses and beds of shale.	Unknown.
Pre-Cambrian			Granite, gneiss, metarhyolite, schist, and greenstone.	Unknown.

^aFrom Anaconda (1976).

Table A2. Annual Frequency Distribution, Stability Class A

Direction	Windspeed (mph)						Total
	0-3	4-6	7-11	12-16	17-25	> 25	
N	24	9	1	0	0	0	34
NNE	11	5	1	0	0	0	17
NE	8	8	2	0	0	0	18
ENE	12	5	1	0	0	0	18
E	7	2	1	0	0	0	10
ESE	5	2	1	0	0	0	8
SE	0	0	0	0	0	0	0
SSE	0	0	0	0	0	0	0
S	1	0	0	0	0	0	1
SSW	3	1	0	0	0	0	4
SW	7	0	0	0	0	0	7
WSW	7	3	1	0	0	0	11
W	10	2	1	0	0	0	13
WNW	12	7	2	0	0	0	21
NW	20	7	0	0	0	0	27
NNW	19	7	0	0	0	0	26

Table A3. Annual Frequency Distribution, Stability Class B

Direction	Windspeed (mph)						Total
	0-3	4-6	7-11	12-16	17-25	> 25	
N	25	8	1	0	0	0	34
NNE	17	7	2	0	0	0	26
NE	17	3	0	0	0	0	20
ENE	16	3	0	0	0	0	19
E	14	4	1	0	0	0	19
ESE	7	2	1	0	0	0	10
SE	4	0	0	0	0	0	4
SSE	6	1	1	0	0	0	8
S	9	0	0	0	0	0	9
SSW	12	6	2	0	0	0	20
SW	14	2	1	0	0	0	17
WSW	14	5	1	1	0	0	21
W	29	7	2	0	0	0	38
WNW	26	8	3	0	0	0	37
NW	33	8	3	0	1	0	45
NNW	27	9	3	2	0	0	41

Table A4. Annual Frequency Distribution, Stability Class C

<i>Direction</i>	<i>Windspeed (mph)</i>						<i>Total</i>
	<i>0-3</i>	<i>4-6</i>	<i>7-11</i>	<i>12-16</i>	<i>17-25</i>	<i>> 25</i>	
N	44	32	8	1	0	0	85
NNE	39	10	5	0	0	0	54
NE	26	6	2	0	0	0	34
ENE	17	4	1	0	0	0	22
E	27	6	0	0	0	0	33
ESE	21	16	2	0	0	0	39
SE	10	17	2	0	0	0	29
SSE	20	12	1	1	0	0	34
S	20	11	10	4	1	0	46
SSW	32	15	4	0	0	0	51
SW	34	15	9	0	0	0	58
WSW	62	17	12	0	0	0	91
W	60	17	9	0	0	0	86
WNW	52	24	8	1	0	0	85
NW	49	26	8	1	0	0	84
NNW	35	21	5	0	1	0	62

Table A5. Annual Frequency Distribution, Stability Class D

<i>Direction</i>	<i>Windspeed (mph)</i>						<i>Total</i>
	<i>0-3</i>	<i>4-6</i>	<i>7-11</i>	<i>12-16</i>	<i>17-25</i>	<i>> 25</i>	
N	72	40	40	1	0	0	153
NNE	62	19	10	2	0	0	93
NE	40	8	5	0	0	0	53
ENE	49	16	3	1	0	0	69
E	46	22	1	0	0	1	70
ESE	67	33	22	0	0	0	122
SE	46	58	46	2	0	0	152
SSE	51	43	36	6	1	0	137
S	37	33	15	5	3	0	93
SSW	83	44	25	7	1	0	160
SW	91	38	44	20	8	0	201
WSW	99	53	64	40	8	0	264
W	164	47	68	24	2	0	305
WNW	151	54	63	22	1	0	291
NW	114	56	53	5	2	0	230
NNW	110	59	54	5	0	0	228

Table A6. Annual Frequency Distribution, Stability Class E

Direction	Windspeed (mph)						Total
	0-3	4-6	7-11	12-16	17-25	> 25	
N	47	30	28	4	1	0	110
NNE	21	11	10	2	0	0	44
NE	18	5	5	1	0	1	30
ENE	14	6	2	2	0	0	24
E	18	7	4	1	0	0	30
ESE	11	21	13	0	0	0	45
SE	17	33	27	1	0	0	78
SSE	35	59	89	17	7	1	208
S	57	28	52	16	8	6	167
SSW	79	33	32	9	15	4	172
SW	76	78	39	25	17	0	235
WSW	96	48	79	77	46	6	352
W	178	65	89	66	24	0	422
WNW	170	100	74	31	25	1	401
NW	98	101	77	46	20	0	342
NNW	69	114	67	6	4	0	260

Table A7. Annual Frequency Distribution, Stability Class F

Direction	Windspeed (mph)						Total
	0-3	4-6	7-11	12-16	17-25	> 25	
N	2	4	4	0	0	0	10
NNE	1	2	0	0	0	0	3
NE	1	1	0	1	0	0	3
ENE	0	1	0	0	0	0	1
E	0	0	1	0	0	0	1
ESE	0	1	0	0	0	0	1
SE	0	2	3	0	0	0	5
SSE	1	2	16	1	0	0	20
S	8	12	24	4	2	1	51
SSW	16	8	8	6	0	1	39
SW	16	12	17	5	2	1	53
WSW	7	9	21	8	4	7	56
W	21	5	4	3	1	1	35
WNW	33	10	14	9	6	0	72
NW	12	11	25	9	5	0	62
NNW	3	19	23	0	0	0	45

Table A8. Annual Frequency Distribution, Stability Class G

Direction	Windspeed (mph)						Total
	0-3	4-6	7-11	12-16	17-25	> 25	
N	0	1	0	0	0	0	1
NNE	0	0	0	0	0	0	0
NE	1	0	0	0	0	0	1
ENE	1	0	0	0	0	0	1
E	3	0	0	0	0	0	3
ESE	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0
SSE	0	0	0	1	0	0	1
S	0	1	5	0	0	0	6
SSW	0	1	1	1	2	0	5
SW	5	5	3	0	0	0	13
WSW	12	3	4	1	0	0	20
W	1	2	2	0	0	0	5
WNW	1	0	1	1	1	0	4
NW	1	1	3	0	0	0	5
NNW	0	1	0	0	0	0	1

Table A9. Annual Frequency Distribution, All Stability Classes

Direction	Windspeed (mph)						Total
	0-3	4-6	7-11	12-16	17-25	> 25	
N	214	124	82	6	1	0	427
NNE	151	54	28	4	0	0	237
NE	111	31	14	2	0	1	159
ENE	109	35	7	3	0	0	154
E	115	41	8	1	0	1	166
ESE	111	75	39	0	0	0	225
SE	77	110	78	3	0	0	268
SSE	113	117	143	26	8	1	408
S	132	85	106	29	14	7	373
SSW	225	108	72	23	18	5	451
SW	243	150	113	50	27	1	584
WSW	297	138	182	127	58	13	815
W	463	145	175	93	27	1	904
WNW	445	203	165	64	33	1	911
NW	327	210	169	61	28	0	795
NNW	263	230	152	13	5	0	663

STATION 701, DECEMBER 1977

STATION 701, JANUARY 1978

Figure A1. Radon Concentration by Hour at the Elkins Background Station 701.

STATION 701, APRIL 1978

STATION 701, MAY 1978

Figure A1. Continued.

STATION 701, JUNE 1978

STATION 701, JULY 1978

Figure A1. Continued.

STATION 701, SEPTEMBER 1978

STATION 701, OCTOBER 1978

Figure A1. Continued.

STATION 701, NOVEMBER 1978

Figure A1. Continued.

STATION 701, DECEMBER 1977

STATION 701, JANUARY 1978

Figure A2. Radon-Concentration Frequency at the Elkins Background Station 701.

STATION 701, APRIL 1978

STATION 701, MAY 1978

Figure A2. Continued.

STATION 701, JUNE 1978

STATION 701, JULY 1978

Figure A2. Continued.

STATION 701, SEPTEMBER 1978

STATION 701, OCTOBER 1978

Figure A2. Continued.

STATION 702, DECEMBER 1977

STATION 702, JANUARY 1978

Figure A3. Radon Concentration by Hour at the McBride Background Station 702.

STATION 702, APRIL 1978

STATION 702, MAY 1978

Figure A3. Continued.

STATION 702, JUNE 1978

STATION 702, JULY 1978

Figure A3. Continued.

STATION 702, SEPTEMBER 1978

STATION 702, OCTOBER 1978

Figure A3. Continued.

STATION 702, DECEMBER 1977

STATION 702, JANUARY 1978

Figure A4. Radon-Concentration Frequency at the McBride Background Station 702.

STATION 702, APRIL 1978

STATION 702, MAY 1978

Figure A4. Continued.

STATION 702, JUNE 1978

STATION 702, JULY 1978

Figure A4. Continued.

STATION 702, SEPTEMBER 1978

STATION 702, OCTOBER 1978

Figure A4. Continued.

STATION 102, JULY 1977

STATION 102, AUGUST 1977

Figure A5. Radon Concentration by Hour at Station 102.

STATION 102, SEPTEMBER 1977

STATION 102, OCTOBER 1977

Figure A5. Continued.

STATION 102, NOVEMBER 1977

STATION 102, DECEMBER 1977

Figure A5. Continued.

STATION 102, MARCH 1978

STATION 102, APRIL 1978

Figure A5. Continued.

STATION 102, MAY 1978

STATION 102, JUNE 1978

Figure A5. Continued.

STATION 103, JULY 1977

STATION 103, AUGUST 1977

Figure A6. Radon Concentration by Hour at Station 103.

STATION 103, SEPTEMBER 1977

STATION 103, OCTOBER 1977

Figure A6. Continued.

STATION 103, NOVEMBER 1977

STATION 103, DECEMBER 1977

Figure A6. Continued.

STATION 103, MARCH 1978

STATION 103, APRIL 1978

Figure A6. Continued.

STATION 103, MAY 1978

STATION 103, JUNE 1978

Figure A6. Continued.

STATION 103, JULY 1978

Figure A6. Continued.

STATION 104, JULY 1977

STATION 104, AUGUST 1977

Figure A7. Radon Concentration by Hour at Station 104.

STATION 104, SEPTEMBER 1977

STATION 104, OCTOBER 1977

Figure A7. Continued.

STATION 104, NOVEMBER 1977

STATION 104, DECEMBER 1977

Figure A7. Continued.

Figure A7. Continued.

STATION 102, JULY 1977

STATION 102, AUGUST 1977

Figure A8. Radon-Concentration Frequency at Station 102.

STATION 102, SEPTEMBER 1977

STATION 102, OCTOBER 1977

Figure A8. Continued.

STATION 102, NOVEMBER 1977

STATION 102, DECEMBER 1977

Figure A8. Continued.

STATION 102, MARCH 1978

STATION 102, APRIL 1978

Figure A8. Continued.

STATION 102, MAY 1978

STATION 102, JUNE 1978

Figure A8. Continued.

STATION 103, JULY 1977

STATION 103, AUGUST 1977

Figure A9. Radon-Concentration Frequency at Station 103.

STATION 103, SEPTEMBER 1977

STATION 103, OCTOBER 1977

Figure A9. Continued.

STATION 103, NOVEMBER 1977

STATION 103, DECEMBER 1977

Figure A9. Continued.

STATION 103, MARCH 1978

STATION 103, APRIL 1978

Figure A9. Continued.

STATION 103, MAY 1978

STATION 103, JUNE 1978

Figure A9. Continued.

STATION 103, JULY 1978

Figure A9. Continued.

STATION 104, JULY 1977

STATION 104, AUGUST 1977

Figure A10. Radon-Concentration Frequency at Station 104.

STATION 104, SEPTEMBER 1977

STATION 104, OCTOBER 1977

Figure A10. Continued.

STATION 104, NOVEMBER 1977

STATION 104, DECEMBER 1977

Figure A10. Continued.

STATION 104, MARCH 1978

Figure A10. Continued.

STATION 102, JULY 1977

STATION 102, AUGUST 1977

Figure A11. Working Level by Hour at Station 102.

STATION 102, SEPTEMBER 1977

STATION 102, OCTOBER 1977

Figure A11. Continued.

STATION 102, NOVEMBER 1977

STATION 102, DECEMBER 1977

Figure A11. Continued.

STATION 102, MARCH 1978

STATION 102, APRIL 1978

Figure A11. Continued.

STATION 102, JUNE 1978

Figure A11. Continued.

STATION 103, JULY 1977

STATION 103, AUGUST 1977

Figure A12. Working Level by Hour at Station 103.

STATION 103, SEPTEMBER 1977

STATION 103, OCTOBER 1977

Figure A12. Continued.

STATION 103, NOVEMBER 1977

STATION 103, DECEMBER 1977

Figure A12. Continued.

STATION 103, MARCH 1978

STATION 103, APRIL 1978

Figure A12. Continued.

STATION 103, MAY 1978

STATION 103, JUNE 1978

Figure A12. Continued.

STATION 103, JULY 1978

Figure A12. Continued.

STATION 104, JULY 1977

STATION 104, AUGUST 1977

Figure A13. Working Level by Hour at Station 104.

STATION 104, SEPTEMBER 1977

STATION 104, OCTOBER 1977

Figure A13. Continued.

STATION 104, FEBRUARY 1978

STATION 104, MARCH 1978

Figure A13. Continued.

STATION 102, JULY 1977

STATION 102, AUGUST 1977

Figure A14. Working-Level Frequency at Station 102.

STATION 102, SEPTEMBER 1977

STATION 102, OCTOBER 1977

Figure A14. Continued.

STATION 102, NOVEMBER 1977

STATION 102, DECEMBER 1977

Figure A14. Continued.

STATION 102, MARCH 1978

STATION 102, APRIL 1978

Figure A14. Continued.

STATION 102, JUNE 1978

Figure A14. Continued.

STATION 103, JULY 1977

STATION 103, AUGUST 1977

Figure A15. Working-Level Frequency at Station 103.

STATION 103, SEPTEMBER 1977

STATION 103, OCTOBER 1977

Figure A15. Continued.

STATION 103, NOVEMBER 1977

STATION 103, DECEMBER 1977

Figure A15. Continued.

STATION 103, MARCH 1978

STATION 103, APRIL 1978

Figure A15. Continued.

STATION 103, MAY 1978

STATION 103, JUNE 1978

Figure A15. Continued.

STATION 103, JULY 1978

Figure A15. Continued.

STATION 104, JULY 1977

STATION 104, AUGUST 1977

Figure A16. Working-Level Frequency at Station 104.

STATION 104, SEPTEMBER 1977

STATION 104, OCTOBER 1977

Figure A16. Continued.

STATION 104, DECEMBER 1977

STATION 104, JANUARY 1978

Figure A16. Continued.

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